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Chronology of Appearance and Habitat Partitioning by Stream Larval Fishes

KEITH B. FLOYD, ROBERT D. HOYT, AND SHIRLEY TIMBROOK

Department of Biology, Western Kentucky University
Bowling Green, Kentucky 42101

Abstract

Larval and juvenile representatives of 28 species were collected from a small stream in Kentucky in 1982 with light traps, push seine, and drift net. The majority of both larvae and juveniles were captured in the light trap; fewer than 1% were taken in drift samples. All but three species were taken at least once in the light traps. Most larvae and juveniles congregated along shoreline areas and used most of the eight habitat areas sampled to some extent. Sunfish species tended to stay in the same general shoreline areas where spawned, whereas riffle–current species left their nest sites as larvae and moved to shoreline nursery areas. Species captured as drift specimens were mostly channel catfish *Ictalurus punctatus* and flathead catfish *Pylodictis olivaris*. With exceptions, the order of species appearance was cottids, percids, catostomids, cyprinids, centrarchids, and ictalurids. There was considerable overlap of species and resource sharing was extensive. The duration of larva occurrences ranged from 16 weeks for logperch *Percina caprodes* to 3 weeks for catfish. Spawning duration was influenced by individual species' behavior and water influxes.

Stream-fish communities are complex species aggregates that have been extensively studied (Gerking 1953; Kuehne 1962; Minckley 1963; Harrel et al. 1967; Sheldon 1968; Whiteside and McNatt 1972; Harima and Mundy 1974; Hoyt et al. 1979). Although most adult fishes have a "behavioral flexibility" that allows them to interact successfully with members of other species and individuals from other stream areas, the young of many species are ecologically distinct from the adults (Moyle and Cech 1982). However, little information is available on the ecology of stream larval fishes. This is due in part to the relatively recent interest in the study of larval fish, the greater economic benefits of studying industrial–municipal impacts on larval fish, the availability of effective quantitative sampling gear for use in marine, lentic, or large lotic systems, and the absence of adequate sampling gear for small lotic systems.

The Middle Fork of Drake's Creek is a small spring-fed stream in south-central Kentucky, the adult ichthyofauna of which has been described by Bell and Hoyt (1980). The objectives of this study were to (1) compare the efficiencies of a light trap, a push seine, and a drift net for capture of larval and juvenile fishes; (2) identify the habitat areas used by larval and juvenile fishes in the Middle Fork; and (3) outline the spawning chronology of the stream fishes.

Study Area

The study area was located 3.8 km upstream from the mouth of the Middle Fork of Drake's Creek, Warren County, Kentucky. Stream width in the study area ranged from 7 to 40 m. Nine sampling sites were established in various habitats.

Stations 1 and 2 were along a shoreline vegetated with water willow *Justica* sp. in backwater areas having a substrate of silt over clay. Both areas were quiet eddy zones separated from the current by exposed shoals. Mean depth of the two sampling areas was 57 cm.

Station 3 was along an undercut bank where the current was noticeable. The substrate was of large gravel and mud and the sampling depth was 61 cm.

Station 4 was adjacent to an undercut mud bank in the middle of a prominently exposed tangle of tree roots. The bank overhang was approximately 50 cm above the water and 30 m long. The substrate was sheet bedrock overlain with small to medium-sized rubble. Mean depth was 38 cm.

Station 5 was in a small pool containing exposed tree roots along the bank. The substrate was bedrock overlain with silt and the water depth was 41 cm.

Station 6 was an open-water, eddy area of the

TABLE 1.—*Numbers of young fish in the Middle Fork of Drake's Creek, Kentucky, summer 1982, by habitat and gear type. P = protolarvae; L = older larvae; J = juveniles.*

		Habitat and station number									Gear type	
		Vegetated shoreline		Undercut bank		Pool		Rock				
				Current	Roots	Roots	Open	Gravel	Algae	Drift net		
Species	Stage	1	2	3	4	5	6	7	8	9	Light trap	Seines
					Catostomidae							
Northern hog sucker	P	4	5	3	6	4	0	14	1	0	37	0
Hypentelium nigricans	L	5	3	10	34	57	3	16	124	0	181	71
	J	0	0	10	0	0	0	0	1	0	0	1
Moxostoma spp.	P	0	0	0	0	0	0	0	0	0	0	0
	L	119	15	1	18	0	0	10	109	1	48	224
	J	0	0	0	4	0	0	2	0	0	4	2
					Centrarchidae							
Rock bass	P	0	0	0	0	0	0	0	0	0	0	0
Ambloplites rupestris	L	2	0	7	3	1	0	3	0	0	16	1
	J	0	1	0	0	0	0	1	0	0	2	0
Green sunfish	P	5	0	0	0	0	0	11	5	0	21	0
Lepomis cyanellus	L	0	0	0	2	0	0	4	1	1	4	3
	J	0	0	0	0	0	0	0	0	0	0	0
Bluegill	P	0	0	0	0	0	0	0	0	0	0	0
Lepomis macrochirus	L	4	6	1	17	1	6	16	55	6	97	9
	J	0	0	0	0	0	0	0	0	0	0	0
Longear sunfish	P	0	0	0	0	0	0	0	0	0	0	0
Lepomis megalotis	L	21	8	1	11	3	2	77	55	5	151	27
	J	0	0	0	0	0	0	0	0	0	0	0
Black bass	P	0	0	0	0	0	0	0	0	0	0	0
Micropterus spp.	L	1,709	6	0	9	0	0	9	9	1	1,478	262
	J	324	3	0	0	0	0	0	0	1	327	0
					Cottidae							
Banded sculpin	P	0	0	0	0	0	0	0	0	0	0	0
Cottus carolinae	L	0	0	0	0	0	0	0	0	0	0	0
	J	1	0	0	0	0	0	0	11	0	0	12
					Cyprinidae							
Common carp	P	0	0	0	2	0	0	5	9	0	16	0
Cyprinus carpio	L	0	0	0	0	0	0	0	1	0	1	0
	J	0	0	0	0	0	0	0	0	0	0	0
Cyprinid—unidentified	P	0	0	0	19	0	1	30	22	0	69	3
Species A	L	0	0	0	0	0	0	0	0	0	0	0
	J	0	0	0	0	0	0	0	0	0	0	0
Species B	P	3	0	0	3	0	2	17	4	0	29	0
	L	1	0	0	0	0	0	2	9	0	12	0
	J	0	0	0	0	0	0	0	0	0	0	0
Species C	P	0	0	0	0	0	8	0	0	0	8	0
	L	0	0	0	0	0	10	0	0	0	10	0
	J	0	0	0	0	0	0	0	0	0	0	0
Species D	P	0	0	0	0	0	0	0	0	0	0	0
	L	0	0	0	1	0	0	0	0	0	1	0
	J	0	0	0	0	0	0	0	0	0	0	0
Species E	P	0	0	0	0	9	24	0	1	0	34	0
	L	0	0	0	0	0	0	0	2	0	2	0
	J	0	0	0	0	0	0	0	0	0	0	0
Species F	P	0	0	0	0	0	0	0	0	0	0	0
	L	0	0	0	0	0	0	1	2	1	3	0
	J	0	0	0	0	0	0	0	0	0	0	0

TABLE 1.—*Continued.*

		Habitat and station number									Gear type	
		Vegetated shoreline		Undercut bank		Pool		Rock				
				Cur-rent	Roots	Roots	Open	Gravel	Algae	Drift net	Light trap	Seines
Species	Stage	1	2	3	4	5	6	7	8	9		
Common shiner	P	19	6	2	9	1	1	22	0	0	60	0
Notropis cornutus	L	35	9	0	7	1	4	55	4	0	104	11
	J	0	3	0	1	1	5	0	0	0	10	0
Rosyface shiner	P	4	1	0	10	21	0	4	3	0	43	0
Notropis rubellus	L	8	4	1	15	8	13	32	64	0	129	16
	J	0	0	1	0	1	6	0	5	0	11	2
Spotfin shiner	P	12	13	3	41	2	25	50	39	0	185	0
Notropis spilopterus	L	13	1	2	51	11	53	5	23	1	157	2
	J	0	0	0	4	2	12	0	2	0	20	0
Bluntnose minnow	P	40	8	2	13	12	20	37	40	0	172	0
Pimephales notatus	L	28	0	1	13	5	36	33	16	1	129	3
	J	0	0	0	10	2	2	1	3	0	16	2
Creek chub	P	0	0	0	0	0	0	0	0	0	0	0
Semotilus atromaculatus	L	22	2	1	3	0	1	6	189	1	30	194
	J	0	0	0	0	0	0	3	33	0	3	33
				Ictaluridae								
Channel catfish	P	0	0	0	0	0	0	0	0	0	0	0
Ictalurus punctatus	L	0	0	0	0	0	0	0	1	0	0	1
	J	0	0	0	0	0	0	0	0	55	0	0
Flathead catfish	P	0	0	0	0	0	0	0	0	0	0	0
Pylodictis olivaris	L	0	0	0	0	0	0	0	0	0	0	0
	J	0	0	0	0	0	0	0	0	7	0	0
				Percidae								
Orangefin darter	P	3	2	3	5	0	2	9	8	0	30	2
Etheostoma bellum	L	0	0	0	13	0	3	3	27	0	45	1
	J	0	0	0	0	0	0	2	1	0	2	1
Greenside darter	P	13	0	3	32	29	0	89	206	0	294	78
Etheostoma blennioides	L	11	0	6	74	21	1	26	23	0	148	14
	J	0	0	0	0	0	0	0	2	0	0	2
Rainbow darter	P	11	1	7	22	46	11	32	59	0	189	2
Etheostoma caeruleum	L	0	0	0	0	0	0	0	0	0	0	0
	J	0	0	0	0	0	0	0	0	0	0	0
Johnny darter	P	8	1	0	21	16	7	42	65	0	158	2
Etheostoma nigrum	L	20	2	0	9	5	3	4	15	0	57	1
	J	0	0	0	0	0	0	0	0	0	0	0
Darter—unidentified	P	1	0	0	10	13	4	93	71	0	192	0
Ulocentra sp.	L	12	26	0	9	9	14	47	32	0	143	6
	J	0	0	0	0	2	0	0	0	0	2	0
Logperch	P	19	6	1	6	0	16	12	28	1	95	0
Percina caprodes	L	0	1	0	3	0	1	5	7	1	16	1
	J	0	0	0	0	0	0	0	0	0	0	0

same pool used for station 5. The substrate was silt and sand. The depth of the sample area was 47 cm, 2.5 m from the bank.

Station 7 was at the upstream end of a limestone outcrop. The substrate was bedrock completely overlain with large gravel. The outcrop ledge was approximately 1.5 m in height, 55 m long, and extended out into the stream 1.5 m at its widest point. The sampling area was 44 cm deep at the face of the outcrop.

Station 8 was approximately 9 m downstream from station 7 along the same rock outcrop. The substrate of bedrock and rubble was completely matted over with filamentous algae *Cladophora* and *Oedogonium* spp. This area was 71 cm deep.

Station 9 was in the midstream current, just above a riffle–chute area. The substrate was of gravel–rubble and the depth was 50 cm.

Methods

Larval and young juvenile fish were collected twice a week from 18 March to 29 July 1982, and on 5 and 12 August and 9 September. No sample was taken on 27 May due to high water. Except as noted, three types of gear were used during each sampling effort. A conical ichthyoplankton drift net, 0.5-m diameter, 0.5-mm mesh, was set at station 9 for three 5-minute intervals, 0.5, 1.5, and 3.5 hours after sunset. A larval-fish seine, 1.5 m long, 1 m deep, 0.5-mm mesh, was pushed through the sampling area of each light trap, immediately before the light-trap sample was taken, at stations 1–8. Light traps were operated for 40 minutes during each sampling effort from 29 April through 9 September, except during periods of turbid water from 20 May to 3 June and 18 July to 5 August. A semiquantitative "unit of effort" comprised three drift-net sets, eight seine pulls, and eight light-trap sets each sampling night.

Light traps were of our design. They were 44.8 cm high and consisted of four 7.6-cm-diameter Plexiglas tubes bonded top and bottom to flat Plexiglas plates. Each tube was milled to be three-quarters of a true circle; the margins of adjacent tubes were 1.5 mm apart throughout their entire length, providing easy entry by larvae on any side at any depth along the trap. The light source was an incandescent bulb powered by two 1.5-volt "D" batteries, which was mounted on top of a 1.25-cm-diameter Plexiglas rod in the top Plexiglas plate. The rod was scribed with a spiral line throughout its length, providing for uniform light distribution throughout the center of the trap. In clear stream water, light intensity declined to 2% source intensity (0.14 lux) at a distance of 1 m from the trap as measured with a Photo-resistive cell calibrated to a Tektronix Model J-17 Digital Photometer. The traps were suspended from tripods, limbs, or roots with their tops at the water surface. As the traps were lifted, water and larvae passed from the Plexiglas-tube capture chamber through an opening in the center of the bottom Plexiglas plate into a stainless-steel pan mounted on the bottom, from which the larvae were washed into collection jars and fixed in 10% formalin.

Specimens were stained with alizarin red-S to accentuate myomere and fin-ray elements. Identifications were made with keys by May and Gasaway (1967), Hogue et al. (1976), and Lathrop (1982a). Terminology used for larva stages is that of Snyder (1976). Specimens that could not be identified were sent to the Tennessee Valley Authority Regional Larval Fish Identification and Information Center.

Stream current velocity was determined with a General Oceanics flowmeter. Dissolved oxygen and temperature were measured with a YSI Model 54A oxygen meter. Dissolved-oxygen concentrations never fell below 7 mg/liter during the study.

Results and Discussion

Catch Efficacies

We collected 5,548 fish larvae and 515 juveniles, representing six families and 28 species, during the study (Table 1). Fourteen species contributed over 95% of the catch, and *Micropterus* was the most abundant taxon (both largemouth bass and spotted bass occur in the stream but larvae of these species could not be distinguished). There were more species of cyprinids (12) than of any other family.

Nearly all the larvae were taken by light traps (82%) and push seines (16%); most juveniles (77%) were captured in light traps (Table 1). The light traps were, by far, the most effective sampling gear. Over the entire study, catches per effort were: light traps (96 hours) 51.9 fish/hour; drift nets (9.8 hours), 8.5 fish/hour; seines (312 hauls), 3.2 fish/haul. During periods of peak larva abundance, the differences in catch rate between light traps and drift nets were even more extreme. All but three species were caught at least once in the light traps (larvae of channel and flathead catfishes appeared almost exclusively in drift nets and juvenile banded sculpins were only taken in push seines). As most of the larvae sampled were positively phototrophic, the abundance and diversity of young fishes sampled would have been greatly underestimated had traditional sampling gear been used. Light traps are semiquantitative samplers at best,

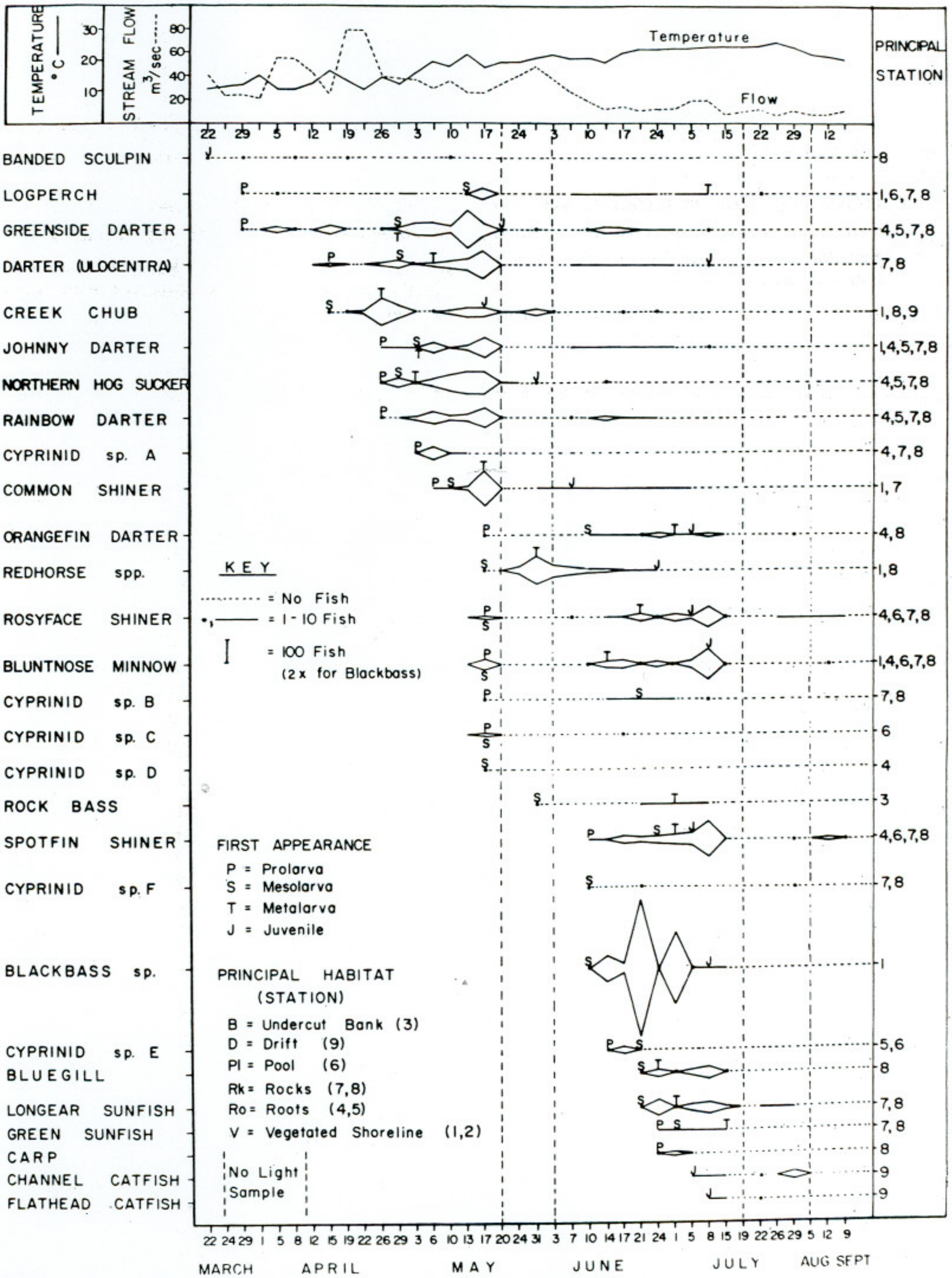

FIGURE 1.—*Stream flow, temperature, and relative abundances of young fish in the Middle Fork of Drake's Creek, Kentucky, 1982. Semiquantitative nightly abundances are based on summed catches by three 5-minute drift-net sets and one seine haul and one 40-minute light-trap set at each of eight stations. When light traps were inoperable, only drift-net and seine catches were summed.*

however; their efficacy varies with water turbidity, and the light intensities to which larvae respond best have not been determined.

Habitat Use

Only 1% of the larvae captured were taken from the drift; as noted, these were predominantly ictalurids (Table 1). Other larvae congregated in placid areas of little flow, and most of the abundant species used most of the habitats sampled to some extent. Use of vegetated shoreline was dominated by black basses. Other species (darters, creek chub, and sunfishes) favored areas with vertical relief: rocks (especially those with algal mats) and roots. Still others were generally distributed in all habitats (suckers, some darters, and most cyprinids) (Table 1; Fig. 1).

Young black bass and sunfishes stayed where they had been spawned but many other larvae had to contend with stream current in order to reach their nursery sites. Darters and catostomids, for example, are spawned in riffles and several cyprinid species nest in current areas. Some of these undoubtedly wash downstream during their translocations, but their scarcity in drift samples taken in this study suggests they are not displaced far.

Species Chronology

Multiple use of nursery areas by fish larvae was somewhat ameliorated by differences in spawning chronology (Fig. 1). Most (but by no means all) non-*Micropterus* larvae that occupied vegetated shoreline areas did so before or after the peak abundance of black bass there. Species that preferred rocks first appeared there at staggered intervals. Nevertheless, there was a great deal of temporal overlap of species—both of larvae and juveniles—in each habitat; resource sharing was extensive.

Spawning by the fish community as a whole occurred over several months and a wide range of temperature. The juvenile banded sculpin caught on 22 March represented a mid- or late-winter spawning for this species (consistent with Wallus and Granneman 1979). The first larva taken was the logperch on 29 March (11.8 C; 10.5 mg/liter dissolved oxygen) and the last were spotfin and rosyface shiners on 9 September (21 C; 9.9 mg/liter dissolved oxygen). With several exceptions, the order of appearance of larvae or juveniles was cottids, percids, catostomids, cyprinids, centrarchids, and ictalurids. This is the order that would be expected (Pflieger 1975) and agrees with that recorded by other investigators of rivers and streams (Gale and Mohr 1978; Gerlach and Kahnle 1982; Lathrop 1982b).

Larvae of individual species also occurred over extended periods—up to 16 weeks for logperch. The average time in weeks that larvae of different groups were collected was percids, 12 weeks; catostomids, 7 weeks; cyprinids, 6 weeks; centrarchids, 4 weeks; and ictalurids, 3 weeks. These extended times are due in part to staggered reproduction by single-time spawners such as the logperch, and several cyprinids (at least) are known to be fractional spawners (Gale 1983). Further, variations in water temperature (up to 6 C) and stream flow (up to 55 cm/second) during the season (Fig. 1) could have caused individual adults to interrupt their spawning. Three periods of high water and decreased temperature were experienced in the stream during the study; 15–26 April, 20 May–3 June, and 18 July–5 August. Presence and abundance of larvae paralleled these stream disturbances. Others have noted prolonged spawning periods for cyprinids and percids (Faber 1982; Lathrop 1982b).

Observations of stream larval fish in this study identified a definite spatial and temporal overlapping of species. However, the degree of actual resource sharing was not determined. Additional studies detailing microhabitat utilization and food habits will be required before species interactions can be described.

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